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TABLE I

Sample	Shear Strength, Psi
Control 1	1630 (650)
Control 2	570 (310)
Control 3	1010 (420)
Control 4	700 (515)
Control 5	1170 (320)
Control 6	970 (33)
Example 1	1420 (165)

The values in parentheses were the standard deviations. three specimens of each sample were tested. The value obtained for Control 1, the mesh bonded steel rod, is considered to be approximate maximum obtainable with the cement tested. In Control 1, the cement itself failed, rather than the interface.

As the foregoing experiment indicates, the addition of a thin, adherent coating of a siliceous material (in this case, silica) to the surface of crystalline alumina enables one to obtain a strong adhesive bond between crystalline alumina and adhesives. In the preferred way of practising the invention, a silane coupling agent is used to enhance the bond between the siliceous coating and the adhesive. The type of silane that is used is dependent upon the nature of the adhesive, as is known in the art. For instance, when an acrylic resin is used as the adhesive (or, indeed, any adhesive that cures by polymerization of an ethylenic double bond), the silane (e.g., A-174) will ordinarily contain an ethylenic double bond that interacts with the resin. If an epoxy adhesive is used, the silane (e.g., A-1100) will usually contain an amino group, preferably a primary amino group, which group will interact with the polymerizing epoxy resin. The principles of selecting a coupling agent to enhance the bond between a siliceous material and an adhesive are known, and the known principles are applicable here.

The invention has been described most particularly with respect to the use of crystalline alpha-alumina (sapphire) as the material from which orthodontic brackets are made. However, other crystalline alumina materials can be used in the invention. The limiting requirements for an orthodontic bracket are adequate modulus of rupture (i.e., greater than about 35,000 psi, which is the yield strength of the steel that is currently used for most orthodontic brackets), and sufficient transparency that the natural tooth color can be seen through the

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Other crystalline alumina materials that can be used include yttrium aluminum garnet, magnesium aluminum spinel, and alpha-alumina in which a small percentage of the aluminum atoms has been replaced with other elements to impart color and/or fluorescence to the crystal. For instance, fluorescence can be imparted to the crystal by the addition of small amounts (e.g., less than 1 mole percent) of terbium oxide or cerium oxide to the aluminum oxide.

The invention is also not limited to orthodontic brackets. It is applicable to any composite wherein a crystalline alumina article is to be bonded to another article. The siliceous coating on the alumina is preferably silica, but can also be other siliceous materials such as glasses that contain significant amounts, usually at least 50 mole percent, of silica. Other materials that can be present in the siliceous material include alkali metal oxides, alkaline earth metal oxides, boron oxide, lead oxide, alumina, rare earth metal oxides (to impart fluorescence), and the like.

What is claimed:

1. A method for applying orthodontic brackets to the teeth of a patient which comprises the steps of:

- (a) providing a crystalline alumina orthodontic bracket comprising a base member including a tooth contacting surface and a body member extending from said base member, said body member including walls defining an archwire groove;
- (b) coating said tooth contacting surface with a thin adherent coating of a siliceous material which consists essentially of silica or a glass containing at least 50 mol percent silica; and
- (c) bonding said bracket to the surface of a tooth with an adhesive having an affinity to said thin adherent coating of siliceous material.

2. The method of claim 1 wherein said siliceous material is silica.

3. The method of claim 1 wherein the adhesive bond between said siliceous material and said silica is enhanced with a silane coupling agent.

4. The method of claim 1 wherein the adhesive is an acrylic material.

5. The method of claim 3 wherein the adhesive is an acrylic material and the silane coupling agent contains olefinic unsaturation.

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